Tibial intramedullary nails—should they be removed?

A retrospective study of 71 patients

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Background **Anterior knee pain and young age of the patient have been considered justification for removal of a tibial intramedullary nail. There have been few reports on the outcome after nail removal, however.**

Patients and methods **We studied 71 patients in whom 72 tibial nails had been removed. We used self-assessment questionnaires to evaluate the location, intensity, and frequency of pain before and after removal. The degree of satisfaction was scored on a visual analog scale.**

Results **39 of 71 patients had less pain after removal of the nail, but were not asymptomatic. 14 patients had unaltered pain, and 18 patients had increased pain. 4 of 6 patients who had been treated with fasciotomy were not satisfied with the outcome of nail removal.**

Interpretation **The results of nail removal to alleviate pain are poor. Removal of a nail should not be undertaken unless there is a convincing indication.**

Intramedullary nailing has been widely accepted as a safe and effective treatment for tibial shaft fractures (Hooper et al. 1991, Bone et al. 1997, Karladani et al. 2000). There is still controversy, however, regarding the indications for nail removal. The decision to remove a tibial nail has largely been a matter of routine—or the patient's own personal choice. Anterior knee pain has also been mentioned as an indication for tibial nail removal (Court-Brown et al. 1997). However, it has not been proven that the nail itself is the cause of the anterior knee pain; furthermore, knee pain may even arise after nail removal (Boerger et al. 1999). We retrospectively identified indications for tibial nail removal and assessed the outcome in a consecutive series of 71 patients.

Patients and methods

We performed a retrospective study on a consecutive series of patients who had had a tibial nail removed. To be included in the study, the patient had to be skeletally mature, and treated with intramedullary nailing for a fresh tibial shaft fracture. We identified 159 patients with 162 tibial shaft fractures in total who had been treated with tibial intramedullary nailing over a 4-year period at 5 departments. 75 of these patients had undergone nail removal; in one case, twice. 4 patients declined to participate in the study, leaving 71 patients (48 males) who had undergone 72 operations for nail removal. The mean age was 35 (15–75) years. The patients gave written informed consent before inclusion in the study, which was approved by the ethics committee of the hospital. The case records and radiographs were evaluated retrospectively. To evaluate the results after removal of the nail, we administered a self assessment questionnaire. All patients answered questions about the reasons for nail removal and the intensity and frequency of pain during the 6 months before removal, the 6 months after nail removal, and at the time of final follow-up. Location of pain and areas of abnormal sensation were marked on the patient's pain draw-

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Table 1. Pain intensity and patient satisfaction on a visual analog scale in 3 groups of patients, based on the result of nail removal. Values are mean (95% CI)

Group (n)	Before nail removal	After nail removal	At the final follow-up	Patient satisfaction
Less pain (40)	5.0 (4.1–6.0)	2.5 (1.8–3.3)	1.5 (0.8–2.1)	7.7 (6.7–8.8)
Unaltered pain (14)	3.0 (1.1–4.9)	3.0 (1.1–4.9)	2.1 (0.4–3.9)	6.5 (4.3–8.8)
Greater pain (18)	2.2 (1.3–3.0)	3.2 (2.2–4.1)	1.4 (0.5–2.4)	6.5 (5.2–8.2)

ing. The degree of satisfaction with the outcome of nail removal was marked on a 10-cm visual analog scale (VAS). The questionnaire was sent to the patients 4 (1–8) years after nail removal.

Statistics

For comparison of continuous variables between 2 groups, we used the Mann-Whitney U-test. For comparison of continuous variables between 3 or more groups without order, Kruskal-Wallis non-parametric analysis of variance was used. Spearman correlation test was used to analyze correlations. Regression coefficients with 95% confidence intervals from linear regression were used to illustrate the increase in the dependent variables for 1 unit increase in the predictor. All tests of significance were two-tailed and interpreted at the 5% level.

Results

The trauma energy at injury was classified as being high in 29 fractures and low in 43 fractures. 2 fractures involved the proximal third, 34 the middle third, and 36 the distal third of the tibial shaft. 8 fractures were complicated by nonunion, but healed after additional intervention. When the cases of nonunion were excluded, the mean healing time was 21 (10–51) weeks. 6 fractures were complicated by compartment syndrome and were treated with fasciotomy of all 4 compartments. Malunion was observed in 7 fractures. Nail removal was performed on average 17 (4–50) months after nail insertion. Prior to removal of the nail, 14 patients were asymptomatic, 13 patients had had occasional pain, 14 patients had had pain during strenuous activities, 15 patients had suffered from pain during moderate activities, and 16 patients had suffered from constant pain.

The reasons for removal of the nail were anterior knee pain in 25 patients, pain in the leg in 9, pain in the ankle joint in 1, infection in 5, and prominent nail or screws in 5. One removal had been done at the patient's request and there was no indication recorded for 26 patients.

Of the 35 patients who had their nail removed to alleviate pain, 10 became asymptomatic. The mean value for pain according to the VAS was 3.9 (95% CI 3.2–4.7) during the 6 months before removal of the nail, 2.8 (2.2–3.6) after removal of the nail, and 1.6 (1.1–2.1) at the final follow-up. Infections and hardware problems were resolved after nail removal.

Nail removal led to a reduced pain score in 40 patients, an unaltered score in 14, and an elevated score in 18 patients (Table 1). 3 patients who had previously been asymptomatic developed pain after nail removal. The patients who experienced pain relief reported greater intensity of pain ($p = 0.002$) before nail removal than those who either experienced greater or unaltered pain (Table 1). However, there were no significant differences regarding intensity of pain after nail removal, pain at the final follow-up, or patient satisfaction in these two groups. There was complete resolution in 1 patient and improvement in symptoms in 15 of 25 patients with anterior knee pain who underwent nail removal. The mean value for pain in patients who suffered constant pain was generally greater than in patients who did not (Table 2). Patients with constant pain reported greater pain before nail removal ($p < 0.001$), after nail removal ($p = 0.003$), and at the final follow-up ($p = 0.001$)—and they were more often dissatisfied ($p = 0.04$) than the patients without constant pain. 42 of 68 patients were satisfied with the result of nail removal. At the final follow-up 25 patients had pain in the knee joint, 11 in the leg, and 11 in the ankle joint.

Table 2. Pain intensity and patient satisfaction on a visual analog scale in 2 groups of patients, based on whether or not the patient had had constant pain before nail removal. Values are mean (95% CI)

Group (n)	Before nail removal	After nail removal	At the final follow-up	Patient satisfaction
Pain before nail removal				
constant (16)	7.8 (6.9–8.6)	4.7 (3.1–6.4)	3.5 (1.9–5.1)	5.5 (3.4–7.8)
not constant (56)	2.8 (2.1–3.5)	2.2 (1.7–2.7)	1.0 (0.6–1.5)	7.6 (6.9–8.5)

Dysesthesia related to the infrapatellar nerve was reported in 31 patients. Of these cases, 12 were associated with superficial peroneal nerve injury. In addition, isolated injury of the superficial peroneal nerve was registered in 6 patients and saphenous nerve injury in 1 patient. Mean patient satisfaction regarding nail removal (from VAS) was 7.2 (95% CI 6.5–8.0). 4 of 6 patients who had been treated with fasciotomy were not satisfied with the outcome of nail removal.

Age, sex, trauma energy, fracture location, healing time, nonunion, malunion, time to nail removal, follow-up time, and presence of infection showed no significant correlation with patient satisfaction, pain before or after nail removal, or pain at the final follow-up.

Discussion

In this study, most nails were removed to alleviate pain, to eradicate infection, or to solve hardware failure. No indication was recorded for 26 patients, however, but some of these patients said that the decision regarding nail removal had been made before nail insertion. Routine nail removal has been encouraged to prevent stress shielding. However, Brumback et al. (1992) found similar stress shielding in patients whether their intramedullary nails had been retained or removed. Another reason for routine nail removal has been to avoid difficult future revision surgery in cases of refracture (Zenios et al. 2004). On the other hand, removal of a tibial nail is not a minor procedure and one should be aware that there are numerous complications associated with nail removal. Re-fracture, failed attempts at nail removal, long operating time, persistent anterior knee pain, and wound infection have been reported by Takakuwa et al. (1997) and Zenios et al. (2004).

An attempt to alleviate pain in different locations (including anterior knee pain) is the commonest reason given for nail removal, but it does not guarantee relief of symptoms and may even cause persistent pain in individuals who were previously asymptomatic. Court-Brown et al. (1997) found anterior knee pain in 56% of patients in a series of 169 patients with a tibial diaphyseal fracture who were treated with intramedullary nailing. They reported that nail removal resolved or improved the symptoms in almost all cases. In an outcome analysis of 100 patients with lower-limb intramedullary nails reported by Boerger et al. (1999), 9 of 16 patients with anterior knee pain showed improvement after tibial nail removal. On the other hand, 4 patients who had previously been asymptomatic developed anterior knee pain following removal. One may criticize the design of our study, which is partly based on the patient's ability to remember the intensity of their pain before nail removal, after an average of 5 years. However, we cannot discount the patient's ability to register the direction of the changes in his/her pain intensity after removal of the nail, i.e. less, unaltered, or greater pain.

The etiology of anterior knee pain after intramedullary nailing is uncertain. In our study, only 1 of 25 patients who had nails removed for anterior knee pain experienced complete relief, while15 showed some improvement. Patients with constant pain before nail removal experienced greater improvement than those who suffered from pain occasionally.

There have been reports of injury to the infrapatellar branch of the saphenous nerve after tibial intramedullary nailing (Robinson et al. 1995, Karladani and Styf 2001). Almost half of the patients

in our study suffered from infrapatellar nerve palsy. Injury of this nerve during an operation can cause pain (Tennent et al. 1998), which, of course, cannot be relieved by removal of the nail. We found a significant correlation between the presence of pain after nail removal and previous fasciotomy. Some of these patients may have had a chronic compartment syndrome.

In summary, we have found that the outcome after nail removal to alleviate pain is generally poor.

Contributions of authors

AHK: designed the study, performed the statistical analyses, and wrote the manuscript. PÅE: did the data collection. HG: helped with study design and helped to write the manuscript. LK and PN: operated on many of the patients.

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Boerger T O. Patel G, Murphy J P. Is routine removal of intramedullary nails justified. Injury 1999; 30 (2): 79-81.

Bone L B, Sucato D, Stegemann P M, Rohrbacher B J. Displaced isolated fractures of the tibial shaft treated with either a cast or intramedullary nailing. An outcome analysisof matched pairs of patients. J Bone Joint Surg (Am) 1997; 79: 1336-41.

Brumback R J, Ellison T S, Poka A, Bathon G H, Burgess A R. Intramedullary nailing of femoral shaft fractures. J Bone Joint Surg (Am) 1992; 74: 106-12.

Court-Brown C M, Gustilo T, Shaw A D. Knee pain after intramedullary tibial nailing: its incidence, etiology, and outcome. J Orthop Trauma 1997; 11 (2): 103-5.

Hooper G J, Keddell R G, Penny I D. Conservative management or closed nailing for tibial shaft fractures. A randomized prospective trial. J Bone Joint Surg (Br) 1991; 73: 83–5.

Karladani A H, Styf J. Percutaneous intramedullary nailing of tibial shaft fractures: a new approach for prevention of anterior knee pain. Injury 2001; 32 (9): 736-9.

Karladani A H, Granhed H, Edshage B, Jerre R, Styf J. Displaced tibial shaft fractures. A prospective randomized study of closed intramedullary nailing versus cast treatment in 53 patients. Acta Orthop Scand 2000; 71 (2): 160–7.

Robinson C M, McLauchlan G J, McLean I P, Court-Brown C M. Distal metaphyseal fractures of the tibia with minimal involvement of the ankle. Classification and treatment by locked intramedullary nailing. J Bone Joint Surg (Br) 1995; 77: 781–7.

Takakuwa M, Funakoshi M, Ishizaki K, Aono T, Hamaguchi H. Fracture on removal of the ACE tibial nail. J Bone Joint Surg (Br) 1997; 79 (3): 444-5.

Tennent T D, Birch N C, Holmes M J, Birch R, Goddard N J. Knee pain and the infrapatellar branch of the saphenous nerve. J R Soc Med 1998; 91 (11): 573–5.

Zenios M, Malik M H A, Al-Mesri A R, Vhadra R, Khan S A. Current intramedullary nail insertion and removal practice in the UK. Eur J Orthop Surg Traumatol 2004; 14: 19–22.